**Title:** Evaluation of the Quebec Healthy Enterprise Standard: Effect on adverse physical and psychosocial work factors and work-related musculoskeletal problems

**Running title:** Effect of QHES on adverse work factors and WMSP

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## Abstract

**Objective:** Evaluate the effect of the Quebec Healthy Enterprise Standard (QHES) on adverse physical and psychosocial work factors and work-related musculoskeletal problems (WMSP).

**Methods:** Workers of ten organizations completed questionnaires before (n=2849) and 2-3 years following (n=2560) QHES implementation. Outcomes were assessed using validated instruments.

**Results**: Workers exposed to adverse physical and psychosocial work factors had a higher prevalence of WMSP. After interventions, the prevalences of one adverse physical and three adverse psychosocial work factors were lower among workers exposed to interventions. Among men exposed to physical and psychosocial interventions, the lower prevalence of neck WMSP is compatible with a beneficial intervention effect. Other results generally showed few effects on WMSP.

**Conclusions**: Results suggest that QHES implementation lead to a decrease in some adverse physical and psychosocial factors. Few effects were observed on WMSP.


**Keywords:** Musculoskeletal problems; Psychosocial work factors; Physical work factors; Workplace intervention; Standard evaluation

## INTRODUCTION

Work-related musculoskeletal problems (WMSP) are among the most frequent and costly health problems experienced by the working population.[1-3] Occupational health reports estimate that over one-fifth of European[1] and Canadian workers[3] suffer from a WMSP. Moreover and despite the fact that WMSP are often under-reported to workers' compensation boards,[4] over a third of work-related illnesses are due to a WMSP, accounting for 34-76% of all work days lost.[1,2,5-7] Efforts to reduce this disabling health problem are thus important and constitute a significant occupational and public health concern.

WMSP refer to painful, non-traumatic inflammatory or degenerative disorders of the musculoskeletal structures of the back, neck and upper or lower extremities.[8] These develop gradually and typically result from an accumulation of damage that exceeds the structures' adaptive capacity.[8] According to Stock's theoretical[9] and validated[10-12] framework, several workplace risk factors can interact to contribute to the development and maintenance of WMSP, including adverse physical and adverse psychosocial work factors. Adverse physical work factors refer to both the biomechanical factors of work (e.g. lifting heavy loads, exerting physical effort) and the physical work environment itself (e.g. workspace and equipment ergonomics). Adverse psychosocial work factors refer to the organizational and interpersonal conditions of a workplace that may negatively affect workers' mental and/or physical health, such as high psychological work demands, low job control, low social support at work and low rewards.[13-15] Several systematic reviews and primary studies provide support for the individual[16-20] and combined[10,11,21,22] role of adverse physical and psychosocial work factors in the etiology of WMSP among workers.

These adverse work factors are modifiable and the implementation of preventive interventions targeting both these factors could potentially improve the musculoskeletal health of workers.[9] However, the vast majority of intervention studies in this area have focused on physical rather than psychosocial workplace risk factors.[23,24] Given the economic and social burden associated with WMSP[1-3,5-7] and the role of adverse physical and psychosocial work factors in their development[9-12,21,22], it would be pertinent to assess the impact of organizational interventions targeting both adverse physical and psychosocial work factors on WMSP.

In Quebec (Canada) in 2008, the Bureau de Normalisation du Quebec (BNQ; the province's standard association) published the voluntary standard *Prevention, Promotion and Organizational Practices Contributing to Health in the Workplace* (BNQ 9700-800/2008),[25] more commonly called the Quebec Healthy Enterprise Standard (QHES). The main purpose of this occupational health standard is to sustainably improve both the physical and mental health of workers. A comprehensive implementation process managed by the BNQ and leading to a certification ensures that the standard is appropriately implemented. Interventions implemented as part of the QHES are tailored to the organizations' occupational context and target four areas of activity known to have an impact on workers' health: *Lifestyle habits*, *Work-life balance*, *Workplace environment*, and *Management practices*. Examples of intervention activities in these

areas can include promoting physical activity and healthy nutritional choices at work (*Lifestyle habits*), providing telecommute options to workers to aid in harmonizing their professional and personal responsibilities (*Work-life balance*), installing ergonomic work stations (*Workplace environment*) and starting an employee recognition program (*Management practices*). Interventions implemented in these latter two areas of the QHES aim to reduce the two main occupational risk factors for WMSP: adverse physical and adverse psychosocial work factors, respectively.[25]

The effect of this innovative standard on workers' musculoskeletal health has not yet been evaluated. The aim of this study was to evaluate the effect of interventions implemented in the context of the QHES on the prevalence of adverse physical and adverse psychosocial work factors. Additionally, the aim was to evaluate the effect of these interventions on the prevalence of WMSP. This is one of the rare studies that evaluated the effect of preventive workplace interventions implemented in the context of a standard. Moreover, this study is one of the few that has evaluated the effect of interventions that aim to reduce both adverse physical and adverse psychosocial work factors on workers' musculoskeletal outcomes, and the first to do so in the context of an occupational standard.

## METHODS

### Study design and population

Details regarding the study design and population have been published elsewhere.[26] Briefly, this is a study derived from secondary data collected by the INSPQ (National Institute of Public Health of Quebec). At the study's conception, organizations that were involved in the certification process and who had enlisted the INSPQ's services to collect data for their needs assessment were invited to participate in the study. All ten organizations agreed to participate. These hailed from the public (7/10) and private (3/10) sectors, namely in public administration (8/10) and also in the manufacturing (1/10) and banking (1/10) sectors. Organization size varied from 103 to 1467 workers encompassing a range of occupations as supervisors, professionals, technicians, office workers, and manual workers. QHES implementation occurred between May 2011 and December 2013 (T1) and a follow-up was completed two to three years later, between May 2014 and November 2015 (T2). The final sample included 2849 workers at T1 (67-90% participation) and 2560 at T2 (63-88% participation).

This project was based on secondary data and, due to privacy issues, it was not possible to pair participants' responses between T1 and T2. In addition, although all organizations collected WMSP information at T2, only two organizations did so at T1. Given these two constraints, a cross-sectional design at T2 was used.

### QHES implementation and certification process

Details regarding the QHES implementation and certification process have been published elsewhere.[26] Briefly, the QHES is a voluntary standard and organizations were responsible for implementing interventions. This is a participatory process involving management engagement, the establishment of a health and well-being committee, a needs assessment and a continuous record of implemented intervention activities.[27] The needs assessment utilizes various methods of internal data collection (such as administrative data, survey data and employees' suggestions) and is used by the health and well-being committee to guide intervention activities. All implemented interventions are recorded in a logbook.[25,27]

The QHES certification process is under the responsibility of the BNQ, the province's standard association. As described previously,[26] the BNQ performs rigorous external audits in order to verify QHES implementation.[27]

### Interventions in the *Workplace environment* and *Management practices* areas of the QHES

Each organization implements interventions that are tailored to their needs and occupational context. As such, interventions in each area vary from one organization to the next. Interventions in the *Workplace environment* area can include increasing the accessibility to tools and equipment that promote safe work, implementing ergonomic programs as well as implementing programs for noise control and ventilation.[25] The *Management practices* area is defined as all the managerial and organizational practices

and methods of work modality.[25] Interventions in this area can thus include the implementation of recognition programs, facilitating the communication channels between management and workers, including workers' in decision-making and opportunities for career development and training.[25]

## Ethical considerations

This project was approved by the Research Ethics Committee of the University of Quebec in Montreal (S-7034324) and the Research Ethics Committee of the CHU de Quebec-Université Laval Research Center (108812). Informed consent was obtained from all participants. Data was made available to the present research team after consent was obtained from all participating organizations. Denomalized databases are stored under password protection on a secure network.

## Data collection and measures

Data were collected by the INSPQ using a self-report questionnaire specifically created to evaluate the QHES. This 30-minute questionnaire was administered at the workplace during work hours and contained a variety of validated items to assess exposure to workplace risk factors and several health outcomes. A supplementary section was added to the T2 questionnaire to assess participants' exposure to QHES interventions, as described below. Qualitative data of implemented interventions were obtained for seven of the 10 participating organizations by members of our research team in order to complement quantitative analyses and fulfill other project objectives.

### *Intervention exposure to the* Workplace environment *area of the QHES*

Participants' perceived exposure to interventions in the *Workplace environment* area of the QHES was assessed in the T2 questionnaire. Participants rated on a four-point Likert-type scale (*none at all, little, enough,* and *many*) the level of changes they perceived in their workplace as a result of interventions in the *Workplace environment* area of the QHES. Participants who responded *none at all* were considered not exposed to this area; all other responses were considered exposed.

### *Intervention exposure to the* Management practices *area of the QHES*

Participants' perceived exposure to interventions in the *Management practices* area of the QHES was assessed in the T2 questionnaire using items adapted from a questionnaire previously used by our research group.[28] Participants rated on a five-point scale the level of changes they observed in their workplace since the implementation of the QHES with regard to 1) workload, 2) autonomy, 3) support from colleagues and superiors and 4) recognition. If participants responded, on any of the five items, that the changes they perceived in their workplace had *improved*, *did not change* or *deteriorated* their work situation, they were considered exposed to interventions. Participants were considered not exposed if they answered either *no change implemented* or *I do not know* to all five items. If all five items were rated as *I do not know*, it was treated as a non-response. The internal consistency (Cronbach's alpha) of these five items was 0.89. This instrument was used for seven organisations which employed, collectively, 86% of the study population. For

the three remaining organisations (14%), one general item was used (similar to the *Workplace environment* exposure item).

### *Adverse physical work factors*

Physical work factors were assessed using five items derived from a Quebec occupational health survey.[3] For four of these items, participants rated on a four-point Likert-type scale from *never* to *all the time* how often they were exposed to the following adverse physical work factors: awkward trunk posture, performing repetitive or precise movements, exerting physical effort at work and handling heavy loads without help. The validity of these items has been demonstrated in a systematic review.[29] Participants were considered exposed to an adverse physical work factor if they responded *often* or *all the time*. For the fifth item, participants rated on a four-point Likert scale how strongly they agreed to a statement that their workspace was designed to promote good posture. Participants were considered exposed to that adverse physical work factor if they responded *disagree* or *strongly disagree*.

### *Adverse psychosocial work factors*

As described in detail elsewhere,[26] psychosocial work factors were assessed using items from the validated versions of Karasek's Job Content Questionnaire[30], Siegrist's ERI Questionnaire[31,32] and proxies from the Copenhagen Psychosocial Questionnaire[33]. For all items, participants rated on a four-point Likert scale how strongly they agreed to statements regarding their work, from *strongly disagree* to *strongly agree*. Scores were dichotomized according to cut-off points corresponding to the medians for the general working population of Quebec.[3] Participants exposed to both high psychological demands and low control are considered exposed to job strain.[13] A ratio of the sum score of the psychological demands scale (proxy of the effort scale, as in previous studies[34]) by the sum score of the rewards scale was calculated. Participants with a ratio over one are considered exposed to ERI.[32]

### *Work-related musculoskeletal problems*

WMSP were assessed using four items adapted from the validated Nordic Questionnaire.[35] Fair to good agreement between self-reported musculoskeletal symptoms and a physical examination of these has been documented.[36] Participants indicated on a four-point Likert-type scale ranging from *never* to *all the time* how often, in the past 12 months, they had felt significant pain that was partially or completely related to their current employment and that had disturbed them during their daily activities in four anatomical regions: neck, back, upper extremities (shoulders, arms, elbows, forearms, wrists, or hands) and lower extremities (hips, thighs, knees, legs, calves, or feet). The questionnaire specifically highlights that any pain due to an injury, trauma, or work accident are excluded from this assessment. Responses on these four items were dichotomized into absence (*never* and *sometimes*) or presence (*often* and *all the time*) of WMSP for each anatomical region.[3] Additionally, a fifth variable was created in which participants with significant pain in at least one anatomical region were coded as having a "WMSP of any region".

### *Covariates*

Collected by questionnaire, covariates were sex, age in years (<44, 45-54, ≥55), highest formal education completed (high school or less, college, university), work status (full-time or part-time worker), seniority (years of employment with current employer), fruit and vegetable consumption (≤2, 3-4, ≥5 servings per day), level of physical activity (<1, 1-2, 3-4, ≥5 per week), and smoker status (non-smoker, ex-smoker, occasional smoker, regular smoker).

## Data analysis

All statistical analyses were conducted using SAS 9.4 software.[37] Chi-square ($\chi 2$) tests were performed to compare participants' characteristics between T1 and T2. Three groups of outcome variables were examined: adverse physical work factors, adverse psychosocial work factors and WMSP. Crude and adjusted prevalence ratios (PRs) and their 95% confidence intervals (CI) were estimated using log-binomial regressions and controlled for clustering by including random effects for organizations.

First, to verify the theoretical assumption that exposure to adverse physical and psychosocial work factors are associated with WMSP, cross-sectional analyses at T2 were computed to determine the association between the prevalence of WMSP of any region and independent and combined exposures to these adverse work factors. Second, cross-sectional analyses at T2 were computed to determine the association between outcomes according to participants' self-reported exposure to interventions in the QHES: 1) adverse physical work factors and exposure to *Workplace environment*; 2) adverse psychosocial work factors and exposure to *Management practices*; and 3) WMSP and exposure to both areas. Three models were computed for each analysis (crude, adjusted for sociodemographic factors, adjusted for sociodemographic and lifestyle factors). Given the similar results these three models provided, only the full model will be presented in the tables (see Supplementary tables for results based on models 1 and 2). The two-tailed statistical significance level was fixed at 0.05. A difference of 15% in outcome prevalence was considered appropriate and of meaningful public health significance considering available data and previous studies in this field. All analyses were also conducted while stratifying by sex.

## RESULTS

Table 1 presents participants' characteristics at baseline (T1) and follow-up (T2). Our sample was composed of equal proportions of men and women. The majority of our participants were under the age of 45 years, were full-time employees and had worked at the participating organization for over 10 years.

As presented in Table 2, the prevalence of WMSP was positively associated with both independent and combined exposure to adverse physical and psychosocial work factors. Participants exposed to three or more adverse physical work factors (PR=2.09, 95%CI=1.94-2.25, $p<0.0001$) or three or more adverse psychosocial work factors (PR=1.69, 95%CI=1.44-1.98, $p<0.0001$) had a higher prevalence of WMSP compared to those exposed to none of these respective factors. Moreover, participants exposed to a combination of at least one adverse physical work factor and at least one adverse psychosocial work factor had a prevalence of WMSP two times higher than unexposed workers (PR=2.26, 95%CI=1.70-3.01, $p<0.0001$). In our sample, these associations were consistently stronger in men than in women.

### After QHES implementation (T2): Prevalence of adverse work factors according to participants' exposure to QHES intervention areas

As shown in Table 3, following QHES implementation 46% of participants reported being exposed to interventions in the *Workplace environment* area, 73% in the *Management practices* area, 42% in both these areas simultaneously and 23% reported that they were not exposed to interventions in neither of these two areas.

Cross-sectional analyses after QHES implementation (T2) revealed that participants who reported being exposed to interventions in the *Workplace environment* area had a lower prevalence of working in a workspace that does not promote good posture compared to those not exposed to interventions in this area (PR=0.63, 95%CI=0.54-0.75, $p<0.0001$). However, the prevalences of all other adverse physical work factors were similar between the two groups, as shown in Table 4. Similar results were observed in the analyses stratified by sex.

As presented in Table 5, the prevalence of exposure to low job control (PR=0.90, 95%CI=0.84-0.96, $p=0.002$), low social support at work (PR=0.79, 95%CI=0.73-0.87, $p<0.0001$) and low rewards (PR=0.86, 95%CI=0.80-0.93, $p<0.0001$) were lower among participants who reported being exposed to interventions in the *Management practices* area of the QHES compared to those not exposed to interventions in this area. Similar results were obtained for the analyses stratified by sex with one exception; low job control was only lower among men exposed to the *Management practices* area (PR=0.82, 95%CI=0.75-0.90, $p<0.0001$). In contrast, the prevalence of exposure to high psychological job demands (PR=1.15, 95%CI=1.03-1.28, $p=0.016$) tended to be higher among participants who reported being exposed to interventions in the *Management practices* area compared to those not exposed to interventions in this area.

**After QHES implementation (T2): Prevalence of WMSP according to participants' exposure to interventions in both QHES areas**

The results for WMSP of the neck were compatible with a beneficial intervention effect, although this was not statistically significant. Indeed, the prevalence of WMSP of the neck was lower among participants exposed to both the *Workplace environment* and *Management practices* areas of the QHES simultaneously compared to those not exposed to either of these areas (PR=0.85, 95%CI=0.70-1.04, $p$=0.115) and this difference was more important among men (PR=0.74, 95%CI=0.52-1.06, $p$=0.099). However, no significant differences in the prevalence of any type of WMSP was observed between participants who reported being exposed to interventions in both areas of the QHES and those who were not exposed to these interventions, as shown in Table 6.

## DISCUSSION

As expected from our theoretical framework,[9] workers exposed to adverse physical and psychosocial work factors had a higher prevalence of WMSP. Regarding adverse work factors, we compared workers who reported being exposed to interventions in each of the *Workplace environment* and the *Management practices* areas of the QHES and those not exposed to these areas. Among workers exposed to these interventions, the prevalence of one adverse physical work factor (workspace that does not promote good posture) and three adverse psychosocial work factors (low job control, low social support at work and low rewards) were lower than in workers not exposed to these interventions. Regarding WMSP, among men exposed to interventions in both areas simultaneously, the results for neck WMSP are compatible with a beneficial intervention effect. Other results generally showed few effects on WMSP.

Our findings on WMSP outcomes could, in part, be explained by the quality and intensity of implemented interventions. In the present study, only 42% of participants reported being exposed to interventions in both the *Workplace environment* and *Management practices* areas of the QHES simultaneously. Moreover, less than half of participants reported being exposed to interventions in the *Workplace environment* area. Although four of the seven organizations with available qualitative data implemented interventions in the *Workplace environment* area, the intervention activities in two of these organizations were merely holding conferences regarding ergonomics and handling heavy loads safely. These types of interventions do not directly reduce adverse physical work factors. Only two organizations aimed to directly reduce these and they did so by developing ergonomic workspaces and equipment. This qualitative data aligns well with our finding that participants who reported being exposed to interventions in the *Workplace environment* area had a lower prevalence of exposure to a workspace that does not promote good posture compared to those not exposed to this area.

Despite this, the evidence regarding the effectiveness of these types of intervention activities in preventing WMSP is mixed. The authors of a recent systematic review of workplace interventions found a moderate level of evidence to suggest that workstation adjustment alone has no effect on WMSP and that ergonomics training activities yield mixed results in their effectiveness to prevent upper extremity WMSP.[23] Moreover, a systematic review of randomized control trials concludes that ergonomic interventions are not more effective in preventing or reducing low back pain and neck pain than no intervention.[38] Although we cannot imply causality, it is thus possible that the lack of an intervention effect on WMSP in our study may be due to the fact that not many organizations chose to implement interventions in the *Workplace environment* area and, of those that did, their choice of interventions included activities that have yielded few beneficial effects on WMSP in the scientific literature.

In contrast to the *Workplace environment* area, almost three-quarters of participants reported being exposed to interventions in the *Management practices* area of the QHES. Five of the seven organizations with available qualitative data implemented interventions in the *Management practices* area. Moreover, each of these five organizations implemented at least three and an average of five intervention activities in this area. The

two most common intervention activities centered on recognition/reward programs and management training to promote a healthy psychosocial work environment. To our knowledge, only two studies have previously examined the impact of an organizational psychosocial intervention on WMSP.[39,40] Of these, only one[39] reported a positive intervention effect on the psychosocial work environment and a decrease in the prevalence of WMSP was observed in that study.[39]

In the present study, no such intervention effect on WMSP was observed. Given that interventions in the *Workplace environment* yielded little effect on adverse physical work factors but that the QHES had a beneficial effect on psychosocial work factors,[26] it is possible that changing the physical work environment may be more important in preventing WMSP. However, it is noteworthy that our results revealed that workers exposed to adverse physical and adverse psychosocial work factors, either independently or in combination, had a higher prevalence of WMSP. These findings, albeit cross-sectional, provide support for Stock's theoretical model[9] and also corroborate previous findings[22,41-43] highlighting the role of both adverse physical and psychosocial work factors in the development of WMSP. As such, it is also possible that the follow-up period was insufficient to affect the musculoskeletal health of participants. It is possible that even if interventions are effective in reducing these adverse factors, it would take some time for the beneficial effects of these to impact musculoskeletal health outcomes. The latency effect could thus possibly, and partially, explain our results.

This study has several strengths that distinguish it from the literature. This is the first study to assess the impact of participative, multi-component interventions targeting both adverse physical and adverse psychosocial work factors implemented in the context of an occupational standard on WMSP outcomes. Quebec's standard association (BNQ) is responsible for the QHES certification process and performs external audits in order to verify QHES implementation.[27] This study also had a large sample size of workers encompassing a wide range of occupations from 10 organizations of various sectors of activity. In addition, the use of qualitative data complemented the quantitative analyses and enriched our interpretation of the results.

Finally, this study has good external validity; a crucial aspect in intervention research with public health implications.[44] The participating organizations adopted the QHES of their own initiative, chose the areas of activity relevant to their needs and developed interventions adapted to their organizational context. Our role as a research group was to assess the impact of the standard as it was interpreted and implemented in the participating organizations, without the interference of researchers. As such, this study assessed the impact of the QHES as it occurred in a natural situation.

The present study also has certain limitations, a number of which are inherent to the use of secondary data. First, the anonymity assured to participants made it impossible to pair participants' responses between T1 and T2. As such, we were unable to neither observe the evolution of adverse work factors and WMSP from before to after QHES implementation nor control for the prevalences of these at baseline, thus limiting our ability to determine causality. Second, our study design lacked a control group which would have allowed us to compare differences in the evolution of outcomes between

organizations that implemented the QHES and those that did not. Third, perceived intervention exposure and outcomes were both assessed in the T2 questionnaire. This may have introduced the common method bias given that the adverse work factors assessed in the questionnaire have an inherent association with the intervention areas of the QHES.

Fourth, two forms of recall bias are possible in this study due to the instruments used to assess WMSP and intervention exposure. For WMSP, participants were asked to recall musculoskeletal pain and symptoms related to their work and experienced in the past 12 months. It is possible that participants recalled musculoskeletal symptoms that were non-work related or were exacerbated by work or that they recall a WMSP that occurred over 12 months ago, thereby leading to an under- or over-reporting of symptoms. For perceived intervention exposure, participants were asked to recall changes that occurred in their workplace due to the QHES. It may be difficult to recall changes and interventions that occurred, thereby leading to an underestimation of QHES intervention exposure. Conversely, participants could remember changes that were implemented that occurred outside of the QHES (for example, an independent exercise program) and attribute it to the QHES, thereby overestimating intervention exposure. Similarly, participants could recall an intervention that was implemented due to the QHES but believe it to be unrelated to the QHES, thereby underestimating intervention exposure.

Finally, the generalizability of these results is limited to other organizations adopting the QHES that have a similar employee profile to that of the 10 participating organizations. More specifically, our participants had a lower prevalence of adverse physical work factors as well as a higher prevalence of adverse psychosocial work factors and WMSP than that documented in a representative occupational health survey of the province of Quebec.[3]

## Conclusion

This is one of the rare studies that evaluated the effect of preventive workplace interventions implemented in the context of an occupational standard. Moreover, this study is one of the few that evaluated the effect of interventions that aim to reduce both adverse physical and adverse psychosocial work factors on workers' musculoskeletal health outcomes. Results suggest that the implementation of the QHES lead to a decrease in some adverse physical and psychosocial work factors. Few beneficial effects were observed on WMSP. Taken together with previous studies, our results suggest that further research is needed to evaluate the effectiveness of interventions targeting both these adverse work factors on musculoskeletal outcomes.

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**Table 1.** Characteristics of the study population before (T1) and after (T2) QHES implementation

| | T1 (N=2849) | | T2 (N=2560) | |
|---|---|---|---|---|
| | **n** | **%** | **n** | **%** |
| **Sex** | | | | |
| Women | 1402 | 49.2 | 1210 | 47.4 |
| Men | 1447 | 50.8 | 1344 | 52.6 |
| **Age groups (years)** | | | | |
| ≤44 | 1410 | 49.5 | 1264 | 49.5 |
| 45-54 | 947 | 33.3 | 823 | 32.2 |
| ≥55 | 491 | 17.2 | 469 | 18.4 |
| **Education (highest level completed)** | | | | |
| High school degree or less | 788 | 27.7 | 687 | 27.1 |
| College degree[a] | 1024 | 36.0 | 896 | 35.3 |
| University degree | 1033 | 36.3 | 957 | 37.7 |
| **Work status** | | | | |
| Full-time | 2611 | 92.4 | 2347 | 93.0 |
| Part-time | 216 | 7.6 | 177 | 7.0 |
| **Seniority (years working for current organization)*** | | | | |
| ≤4 | 777 | 27.4 | 554 | 21.9 |
| 5-9 | 643 | 22.7 | 605 | 23.9 |
| 10+ | 1413 | 49.9 | 1375 | 54.3 |
| **Fruit and vegetable intake (servings/day)** | | | | |
| ≤2 | 293 | 10.3 | 292 | 11.5 |
| 3-4 | 1643 | 57.9 | 1460 | 57.5 |
| ≥5 | 902 | 31.8 | 789 | 31.1 |
| **Weekly frequency of physical activity*** | | | | |
| <1 | 425 | 15.0 | 424 | 16.6 |
| 1-2 | 596 | 21.0 | 464 | 18.2 |
| 3-4 | 1118 | 39.4 | 1053 | 41.3 |
| ≥5 | 701 | 24.7 | 607 | 23.8 |
| **Smoking status** | | | | |
| Non-smoker | 1608 | 56.6 | 1478 | 57.9 |
| Ex-smoker | 813 | 28.6 | 750 | 29.4 |
| Occasional smoker | 136 | 4.8 | 121 | 4.7 |
| Regular smoker | 283 | 10.0 | 204 | 8.0 |

*Note:* QHES= Quebec Healthy Enterprise Standard. Less than 0.01 missing values.

**p*-value for Chi-square test is statistically significant ($p<0.05$)

[a]In the province of Québec, college refers to pre-university education or vocational/technical training.

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**Table 2.** Cross-sectional (T2) associations between the prevalence of WMSP of any region and independent and combined exposure to adverse physical and psychosocial work factors, amongst all participants and by sex

| | WMSP | | | | |
|---|---|---|---|---|---|
| | **n** | **%** | **PR** | **95% CI** | ***p*-value** |
| **Adverse physical work factors** | | | | | |
| **All participants (N=2560)** | | | | | |
| Not exposed | 256 | 26.8 | REF | REF | REF |
| Exposed to 1-2 factors | 573 | 39.9 | **1.46** | **1.35-1.57** | **<0.0001[a]** |
| Exposed to 3+ factors | 252 | 55.8 | **2.09** | **1.94-2.25** | **<0.0001[a]** |
| **Women (n=1210)** | | | | | |
| Not exposed | 135 | 31.4 | REF | REF | REF |
| Exposed to 1-2 factors | 322 | 44.9 | **1.41** | **1.25-1.58** | **<0.0001[a]** |
| Exposed to 3+ factors | 116 | 60.4 | **1.55** | **1.28-1.88** | **<0.0001[a]** |
| **Men (n=1344)** | | | | | |
| Not exposed | 121 | 23.3 | REF | REF | REF |
| Exposed to 1-2 factors | 249 | 34.7 | **1.52** | **1.19-1.95** | **<0.0001[a]** |
| Exposed to 3+ factors | 135 | 51.8 | **2.19** | **1.93-2.49** | **<0.0001[a]** |
| Sex*factor interaction | . | . | . | . | 0.657[a] |
| **Adverse psychosocial work factors** | | | | | |
| **All participants (N=2560)** | | | | | |
| Not exposed | 95 | 27.0 | REF | REF | REF |
| Exposed to 1-2 factors | 383 | 34.4 | **1.29** | **1.14-1.46** | **<0.0001[a]** |
| Exposed to 3+ factors | 604 | 45.5 | **1.69** | **1.44-1.98** | **<0.0001[a]** |
| **Women (n=1210)** | | | | | |
| Not exposed | 59 | 32.9 | REF | REF | REF |
| Exposed to 1-2 factors | 211 | 40.1 | **1.23** | **1.03-1.46** | **0.021[a]** |
| Exposed to 3+ factors | 303 | 49.9 | **1.53** | **1.30-1.81** | **<0.0001[a]** |
| **Men (n=1344)** | | | | | |
| Not exposed | 36 | 20.8 | REF | REF | REF |
| Exposed to 1-2 factors | 171 | 29.2 | **1.39** | **1.04-1.86** | **0.024[a]** |
| Exposed to 3+ factors | 299 | 41.5 | **1.92** | **1.42-2.58** | **<0.0001[a]** |
| Sex*factor interaction | . | . | . | . | 0.237[a] |
| **Combined exposure** | | | | | |
| **All participants (N=2560)** | | | | | |
| Exposed to neither | 38 | 19.6 | REF | REF | REF |
| Exposed to both | 766 | 44.9 | **2.26** | **1.70-3.01** | **<0.0001** |
| **Women (n=1210)** | | | | | |
| Exposed to neither | 25 | 25.1 | REF | REF | REF |
| Exposed to both | 402 | 49.4 | **1.95** | **1.40-2.73** | **<0.0001** |
| **Men (n=1344)** | | | | | |
| Exposed to neither | 13 | 13.5 | REF | REF | REF |

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| | | | | | |
|---|---|---|---|---|---|
| Exposed to both | 361 | 40.4 | **2.91** | **1.76-4.83** | **<0.0001** |
| Sex*factor interaction | . | . | . | . | 0.470 |

*Note*: T2= after QHES implementation; WMSP= work-related musculoskeletal problems; PR= prevalence ratio; 95% CI= 95% confidence interval. Combined exposure= combined exposure to at least one adverse physical and at least one adverse psychosocial work factor. Number of participants with outcome (N) and its associated prevalence (%) may not correspond as prevalence is adjusted for the random effect of organization.

Models adjusted for age, sex, education, full-time or part-time work status, seniority, fruit and vegetable consumption, level of physical activity and smoker status as well as organization as a random effect to take clustering into account in the analyses.

[a]PRs for these models were estimated using Poisson regressions with sandwich variance estimators. Due to numerical problems in these models, we are not confident that the generated *p*-values are precise and these must therefore be interpreted with caution.

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**Table 3.** Frequency and proportion of participants who reported being exposed to interventions in the two QHES areas of interest at T2

| | All participants (N=2420) | | Women (n=1137) | | Men (n=1277) | |
|---|---|---|---|---|---|---|
| | **n** | **%** | **n** | **%** | **n** | **%** |
| **Workplace environment** | | | | | | |
| Exposed | 1114 | 46.0 | 495 | 43.5 | 618 | 48.4 |
| Not exposed | 1306 | 54.0 | 642 | 56.5 | 659 | 51.6 |
| **Management practices** | | | | | | |
| Exposed | 1773 | 73.3 | 848 | 74.6 | 920 | 72.0 |
| Not exposed | 647 | 26.7 | 289 | 24.4 | 357 | 28.0 |
| **Both areas simultaneously** | | | | | | |
| Exposed to both | 1019 | 42.1 | 449 | 39.5 | 569 | 44.6 |
| Exposed to neither | 552 | 22.8 | 243 | 21.4 | 308 | 24.1 |

*Note*: QHES= Quebec Healthy Enterprise Standard; T2= after QHES implementation. 0.06 missing values

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**Table 4.** Prevalence and prevalence ratios (PR) of adverse physical work factors according to participants' self-reported exposure to interventions in the *Workplace environment* area after QHES implementation, amongst all participants and by sex

| | **Not exposed to WE area (N=1306)** | | **Exposed to WE area (N=1114)** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **n** | **%** | **n** | **%** | **PR** | **95% CI** | ***p*-value** | **Sex*time interaction** |
| **Workspace does not promote good posture** | | | | | | | | |
| All participants | 354 | 23.6 | 178 | 14.8 | **0.63** | **0.54-0.75** | **<0.0001** | |
| Women | 172 | 24.8 | 71 | 13.5 | **0.53** | **0.41-0.69** | **<0.0001** | |
| Men | 180 | 22.1 | 107 | 15.8 | **0.74** | **0.59-0.92** | **0.007** | **0.055** |
| **Awkward trunk posture** | | | | | | | | |
| All participants | 374 | 30.2 | 304 | 27.8 | 0.89 | 0.78-1.02 | 0.091 | |
| Women | 179 | 29.2 | 131 | 26.1 | 0.87 | 0.75-1.02 | 0.095[a] | |
| Men | 193 | 31.4 | 173 | 29.4 | 0.90 | 0.79-1.02 | 0.102[a] | 0.695 |
| **Repetitive/precise movements** | | | | | | | | |
| All participants | 618 | 45.7 | 533 | 47.1 | 1.00 | 0.93-1.06 | 0.885[a] | |
| Women | 336 | 51.3 | 274 | 53.8 | 1.02 | 0.93-1.12 | 0.698[a] | |
| Men | 280 | 40.9 | 259 | 41.5 | 0.97 | 0.86-1.09 | 0.597[a] | 0.551 |
| **Physical effort** | | | | | | | | |
| All participants | 197 | 18.1 | 213 | 18.5 | 0.98 | 0.84-1.13 | 0.758[a] | |
| Women | 70 | 12.7 | 60 | 11.4 | 0.88 | 0.66-1.18 | 0.396[a] | |
| Men | 126 | 23.3 | 153 | 25.5 | 1.03 | 0.84-1.26 | 0.796[a] | 0.390 |
| **Handling heavy loads** | | | | | | | | |
| All participants | 131 | 12.0 | 132 | 11.1 | 0.87 | 0.68-1.10 | 0.231 | |
| Women | 44 | 7.4 | 34 | 5.9 | 0.81 | 0.53-1.24 | 0.338 | |
| Men | 86 | 16.4 | 98 | 16.3 | 0.89 | 0.67-1.18 | 0.419 | 0.723 |

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*Note*: QHES= Quebec Healthy Enterprise Standard; WE=*Workplace environment* area of the QHES; 95% CI= 95% confidence interval. N of women not exposed to WE area=642; women exposed=495; men not exposed to WE area=659; men exposed=618. 0.06 missing values. Number of participants with outcome (N) and its associated prevalence (%) may not correspond as prevalence is adjusted for the random effect of organization.
Models adjusted for age, sex, education, full-time or part-time work status, seniority, fruit and vegetable consumption, level of physical activity and smoker status as well as organization as a random effect to take clustering into account in the analyses.
[a]PRs for these models were estimated using Poisson regressions with sandwich variance estimators. Due to numerical problems in these models, we are not confident that the generated *p*-values are precise and these must therefore be interpreted with caution.

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**Table 5.** Prevalence and prevalence ratios (PR) of adverse psychosocial work factors according to participants' self-reported exposure to interventions in the *Management practices* area after QHES implementation, amongst all participants and by sex

| | **Not exposed to MP area (N=647)** | | **Exposed to MP area (N=1773)** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **n** | **%** | **n** | **%** | **PR** | **95% CI** | ***p*-value** | **Sex*time interaction** |
| **High psychological demands** | | | | | | | | |
| All participants | 250 | 36.9 | 740 | 41.0 | **1.15** | **1.03-1.28** | **0.016** | |
| Women | 113 | 36.7 | 341 | 39.2 | 1.09 | 0.93-1.28 | 0.305 | |
| Men | 136 | 36.8 | 398 | 42.7 | **1.19** | **1.03-1.38** | **0.020** | 0.419 |
| **Low job control** | | | | | | | | |
| All participants | 383 | 61.4 | 1008 | 57.1 | **0.90** | **0.84-0.96** | **0.002**[a] | |
| Women | 158 | 56.8 | 495 | 57.9 | 0.99 | 0.91-1.08 | 0.833[a] | |
| Men | 224 | 65.6 | 512 | 56.6 | **0.82** | **0.75-0.90** | **<0.0001**[a] | **<0.0001** |
| **Low social support at work** | | | | | | | | |
| All participants | 341 | 56.1 | 768 | 44.5 | **0.79** | **0.73-0.87** | **<0.0001** | |
| Women | 137 | 50.2 | 348 | 41.3 | **0.83** | **0.72-0.96** | **0.010** | |
| Men | 204 | 62.1 | 419 | 48.0 | **0.77** | **0.69-0.86** | **<0.0001** | 0.425 |
| **Job strain** | | | | | | | | |
| All participants | 136 | 20.2 | 389 | 20.7 | 1.01 | 0.85-1.21 | 0.870 | |
| Women | 60 | 19.8 | 179 | 19.3 | 0.99 | 0.76-1.28 | 0.932 | |
| Men | 75 | 20.4 | 210 | 22.2 | 1.04 | 0.82-1.31 | 0.768 | 0.793 |
| **Low rewards** | | | | | | | | |
| All participants | 432 | 63.6 | 972 | 53.8 | **0.86** | **0.80-0.93** | **<0.0001** | |
| Women | 191 | 61.0 | 444 | 50.2 | **0.82** | **0.74-0.92** | **<0.001** | |
| Men | 241 | 65.5 | 525 | 57.3 | **0.89** | **0.81-0.98** | **0.016** | 0.270 |
| **ERI** | | | | | | | | |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| All participants | 245 | 34.6 | 589 | 31.7 | 0.94 | 0.83-1.06 | 0.307 | |
| Women | 104 | 32.1 | 266 | 29.4 | 0.92 | 0.77-1.11 | 0.403 | |
| Men | 140 | 36.3 | 321 | 33.6 | 0.95 | 0.81-1.11 | 0.511 | 0.828 |

*Note*: QHES= Quebec Healthy Enterprise Standard; MP=*Management practices* area of the QHES; 95% CI= 95% confidence interval; ERI= effort-reward imbalance. N of women not exposed to MP area=289; women exposed=848; men not exposed to MP area=357; men exposed=920. 0.06 missing values. Number of participants with outcome (N) and its associated prevalence (%) may not correspond as prevalence is adjusted for the random effect of organization. Models adjusted for age, sex, education, full-time or part-time work status, seniority, fruit and vegetable consumption, level of physical activity and smoker status as well as organization as a random effect to take clustering into account in the analyses.

[a]PRs for these models were estimated using Poisson regressions with sandwich variance estimators. Due to numerical problems in these models, we are not confident that the generated *p*-values are precise and these must therefore be interpreted with caution.

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**Table 6.** Prevalence and prevalence ratios (PR) of work-related musculoskeletal problems (WMSP) according to participants' self-reported exposure to interventions in both the *Workplace environment* and *Management practices* areas simultaneously after QHES implementation, amongst all participants and by sex

| | **Not exposed to either area (N=552)** | | **Exposed to both areas (N=1019)** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **n** | **%** | **n** | **%** | **PR** | **95% CI** | ***p*-value** | **Sex*time interaction** |
| **WMSP of any region** | | | | | | | | |
| All participants | 225 | 36.2 | 408 | 37.6 | 1.02 | 0.90-1.16 | 0.739 | |
| Women | 118 | 43.6 | 209 | 42.9 | 0.97 | 0.83-1.14 | 0.742 | |
| Men | 106 | 30.1 | 199 | 33.0 | 1.09 | 0.90-1.32 | 0.375 | 0.183 |
| **WMSP of the neck** | | | | | | | | |
| All participants | 127 | 18.2 | 182 | 15.9 | 0.85 | 0.70-1.04 | 0.115 | |
| Women | 76 | 25.1 | 121 | 23.5 | 0.90 | 0.71-1.15 | 0.409 | |
| Men | 50 | 12.4 | 61 | 9.4 | 0.74 | 0.52-1.06 | 0.099 | **0.009** |
| **WMSP of the back** | | | | | | | | |
| All participants | 130 | 19.7 | 243 | 21.0 | 1.06 | 0.88-1.28 | 0.555 | |
| Women | 55 | 19.7 | 124 | 24.1 | 1.21 | 0.92-1.59 | 0.176 | |
| Men | 74 | 19.2 | 119 | 18.4 | 0.94 | 0.72-1.21 | 0.610 | 0.243 |
| **WMSP of the upper extremities** | | | | | | | | |
| All participants | 127 | 21.8 | 230 | 22.1 | 0.97 | 0.80-1.18 | 0.756 | |
| Women | 67 | 26.6 | 128 | 27.5 | 0.99 | 0.77-1.27 | 0.917 | |
| Men | 59 | 18.1 | 102 | 17.6 | 0.95 | 0.70-1.28 | 0.713 | 0.982 |
| **WMSP of the lower extremities** | | | | | | | | |
| All participants | 69 | 12.3 | 142 | 12.9 | 1.04 | 0.79-1.37 | 0.800 | |
| Women | 22 | 9.2 | 67 | 13.4 | 1.52 | 0.96-2.41 | 0.073 | |
| Men | 46 | 14.4 | 75 | 12.5 | 0.80 | 0.56-1.13 | 0.198 | 0.153 |

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*Note*: QHES= Quebec Healthy Enterprise Standard; 95% CI= 95% confidence interval. N of women not exposed to either area=243; women exposed to both areas=449; men not exposed to either area=308; men exposed to both areas=569. 0.06 missing values. Number of participants with outcome (N) and its associated prevalence (%) may not correspond as prevalence is adjusted for the random effect of organization.
Models adjusted for age, sex, education, full-time or part-time work status, seniority, fruit and vegetable consumption, level of physical activity and smoker status as well as organization as a random effect to take clustering into account in the analyses.